Physical Pharmacy Laboratory
2nd stage
College of Pharmacy

Lab.6 : A Study of the Effect of Acid Addition on the pH of Buffer and Non-Buffer Solutions

By : Dr. Nizar Awish Jassem
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Phosphate buffer preparation

Prepare the two stock solutions

- First, choose the concentration of each stock solution. For example, prepare **0.1 M of both**
  - **Solution A — Acidic:** Sodium dihydrogen phosphate, NaH_2PO_4.
  - **Solution B — Basic:** Disodium hydrogen phosphate, Na_2HPO_4.
- For each solution, dissolve the salt (7.8g of NaH_2PO_4 and 7.1g of Na_2HPO_4) in about 400 mL of distilled water, then bring the final volume to exactly 500 ml.

Table for preparing different pH values

Target pH	Acidic A (mL)	Basic B (mL)	Total (mL)
6.0	94.2	5.8	100
6.2	91.1	8.9	100
6.4	86.6	13.4	100
6.6	80.3	19.7	100
6.8	72.0	28.0	100
7.0	61.9	38.1	100
7.2	50.6	49.4	100
7.4	39.2	60.8	100
7.6	28.9	71.1	100
7.8	20.4	79.6	100
8.0	14.0	86.0	100

How to use the table

- For example, to prepare **100 mL of phosphate buffer at pH 7.4**:
  1. Pipette 39.2 mL of Solution A (NaH_2PO_4).
  2. Add 60.8 mL of Solution B (Na_2HPO_4).
  3. Mix thoroughly.
  4. Measure the pH with a calibrated pH meter.
  5. Adjust carefully if needed, and record the final measured pH.
- Because both stocks are 0.1 M, the total phosphate concentration remains approximately 0.1 M.

Procedure:

1. **Preparation of the buffer solution:** Mix 6 mL of Solution A (sodium dihydrogen phosphate, NaH_2PO_4) and 4 mL of Solution B (disodium hydrogen phosphate, Na_2HPO_4) in a clean beaker. Stir thoroughly to obtain a phosphate buffer solution.
2. **Preparation of the non-buffer solution:** Transfer 10 mL of distilled water (D.W.) into a separate clean beaker.
3. **Initial pH measurement:** Measure and record the initial pH of both solutions using a calibrated pH meter.
4. **Addition of acid:** Add 1 mL of 0.1 N hydrochloric acid (HCl) to each solution separately. Mix thoroughly.
5. **Final pH measurement:** Measure and record the pH of both solutions again using the pH meter.
6. **Comparison of results:** Compare the initial and final pH values of both solutions and calculate the change in pH (ΔpH) to evaluate the buffering capacity of the phosphate buffer compared with distilled water.

Recommended experimental results table

Measurement	Buffer solution	Non-buffer solution
Initial pH		
pH after HCl addition		
Change in pH (ΔpH)		

ΔpH **= pH initial - pH final**

Important notes

1. Use the same volume of HCl (1 mL) and the same concentration (0.1 N) for both solutions to ensure a fair comparison.
2. Use separate, clean beakers to avoid cross-contamination.

buffer capacity (β) measures the ability of a buffer solution to resist changes in pH when a strong acid or base is added.

1. Formula for buffer capacity

$$\beta = \frac{\Delta B}{\Delta pH}$$

Where:

β = Buffer capacity.

ΔB = Amount of strong acid or base added per liter of solution (mol/L).

ΔpH = Change in pH after adding the acid or base.

The unit is: $\mathrm{mol\,L^{-1}pH^{-1}}$

2. Application to experiment

- You added 1 mL of 0.1 N HCl to each solution.

Step 1. Calculate the amount of HCl added.

$$\mathbf{Equivalents} = N \times V$$

$$= 0.1 \times 0.001 = 0.0001\ eq$$

For HCl, which is monoprotic:

$$0.0001\ eq = 0.0001\ mol$$

Step 2. Calculate the change in pH.

$$\Delta pH = pH_{\text{initial}} - pH_{\text{final}}$$

Step 3. Calculate buffer capacity.

- If the initial buffer volume is 10 mL and 1 mL HCl is added, the final volume is 11 mL.

$$\beta = \frac{0.0001/0.011}{\Delta pH}$$